

## *Makeup and Breakup of a Medeco Biaxial Lock*



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## Index

Introduction .....	Page 3
External Parts.....	Page 4
Face.....	Page 4
Cam.....	Page 4
Pin Covers .....	Page 5
Keys.....	Page 5 & 6
Key Tag.....	Page 6
Key Control.....	Page 7
Internal Parts.....	Page 8
Plug .....	Page 8
Crescents .....	Page 9
Sidebar .....	Page 9
Top Pins.....	Page 10, 11 & 12
Bottom Pins.....	Page 13
Cylinder.....	Page 13
Strengths and Weaknesses .....	Page 15
Casting.....	Page 15
Hole in Cam.....	Page 15
Drilling .....	Page 15
Master Keying .....	Page 16
Picking .....	Page 17
Pick Jig.....	Page 17
Finished Picks.....	Page 19
Using the Picks.....	Page 19 & 20
Conclusion and Bibliography .....	Page 21

## Introduction

In this article, I will discuss the Medeco Biaxial high security lock. Medeco biaxial is one of the most well known and used high security locks in North America. It combines a normal pin tumbler lock with a rotating pin and sidebar design. This concept was first developed by the **Mechanical Development Company** (Medeco) in 1968. Medeco is currently an Assa Abloy group company, and they provide locks for the US military.

Here you can see a mortise Medeco 51s Biaxial lock with a brass finish and a Z keyway. This is the lock I will be breaking down, and hopefully picking. Medeco locks are available as rim, mortise, interchangeable core, key in knob, cam, and switch locks. Medeco locks, depending on their type, are available in 4, 5, 6, and 7 pin models.



## The External Parts

The face of the lock is clearly stamped with the Medeco name and symbol. In the lower right there is the 51s stamp, indicating the lock is 51s series lock, and below that there is a UL stamp to indicate the lock is UL certified.



Fig. 1- Face of Medeco 51s lock with Z keyway

Looking at the back of the lock all you can see is a stamp, and a cam. The cam is covered; however the cover is not fully effective. There is still a small hole in the bottom, to let the very tip of the key protrude. This hole is security vulnerability, as certain tools can be fed through this hole, and used to bypass the locking mechanism on the door. One example of this kind of tool would be the Adams Rite Trip Wires.



Fig. 2- Rear of Medeco Biaxial lock showing the cam and cover

One excellent feature of the Medeco locks is that instead of using standard sheet metal slide on pin covers, which are easy to bend and ruin, Medeco uses a small hex socket screw. The covers are easily removed with a 5/64" Allen wrench.



Fig. 3- Top of Medeco Biaxial lock showing the removable pin covers.

In order for a key to open a Medeco lock, it must fit the keyway, have the right depth cuts, and the right angular cuts. Most Medeco keys have a square head, with an eagle on them, as well as the patent number, the Medeco name, and "RESTRICTED DO NOT DUPLICATE" stamped on them. The key has six depths available for each pin, and the angles on the key are either center, 20° left, or 20° right. The angle in the valley of the key, where the key touches, is 86°. Medeco locks can be master keyed; however the master key must have the same angular cuts as the operating key, and every other lock in the system it operates.



Fig. 4- Medeco Biaxial key



Fig. 5- Medeco keys, showing the different cut angles on the keys.

Medeco also uses key tags or keycards with their locks. The key tag or card has the information needed to duplicate the key. Medeco originally used key tags, but they have since moved to credit card sized cards with all the information needed to duplicate the key on them. This also works as protection against illegal key copying, and is explained in the “Key Control” section.



Fig. 6- Medeco key tag.

## **Key Control**

Medeco values key control very highly. Their locks are available in four distinct levels of key control.

Starting with the lowest level, Medeco's signature program is for customers who are not very concerned with key control. In order to get additional keys made, customers simply have to go to the locksmith from whom they obtained the lock, and they can then have additional keys made. Due to the keys used for the signature program being widely available, keys could be copied by unauthorized people. The signature program uses AIR keyways.

The card program is for customers looking for more key control than the signature program offers. With their new lock and keys, customers are issued a key card. The customer then signs this card after receiving it. In order to copy a card on the card program, the locksmith needs the card that contains the control data. The locksmith must also verify that the customer's signature matches that on the card. The card program uses SKY keyways.

Contract restricted key control is for businesses that are looking for a special keyway. After entering into a contract with Medeco, they are assigned a special keyway. Once they are assigned this keyway, they can only obtain new keys through a Medeco factory, after having proven their identity. Keys are never distributed to distributors.

The factory program offers the most key control possible. Keys are factory restricted, and are only available to that customer. Key blanks are never sold or distributed. The keys for these locks come precut, and each key in a set is also identified by number, for example 1 of 4, or 3 of 7.



## **The Internal Parts**

The plug is made of brass, and it contains four hardened steel anti-drilling rods. Three of these are at the top of the keyway, and they are to keep someone from drilling out the bottom pins in the lock. The fourth is on the right hand side of the lock, at the 3'oclock position. This is to prevent drilling of the sidebar. Although drilling is possible, these hardened steel rods make it very difficult to drill out the lock in a short period of time.



Fig. 7- Top view of plug, showing hardened anti-drill rods and pin chambers



Fig. 8- Side view of plug, showing sidebar hole and slots, and one hardened Rod.



The lock also contains two hardened crescents. This is to prevent the top pins in the lock from being drilled, as well as to keep the sidebar from being drilled. These crescents are located at the 12 o'clock and 3 o'clock positions in the lock. They are nested in the cylinder itself, and they are removable.



Fig. 9- Hardened crescents.



Fig. 10- Crescent's position in cylinder.

At the front of the sidebar, there is a hardened ball bearing, also to thwart drilling attempts. The tiny sidebar springs force the sidebar out of the pins grooves when the sidebar is in line with the sidebar groove in the side of the cylinder. The sidebar fingers fit into the slots in the key pins.



Fig. 11- Sidebar, with springs and hardened ball bearing.

The Medeco biaxial key pins (bottom pins) are made of nickel plated CDA340 hard brass. They are available in six different sizes. As you can see from looking at the pictures below, each pin has a long chisel face and a short chisel face. Pins also have a sidebar slot, as well as a 0.015" flat at the bottom of the pin, which is offset 0.031" to the left or the right of the centerline of the pin. Each pin has a 0.135" diameter, which is 0.020" larger than the standard pins in a pin tumbler lock. Each pin also has a slot cut in the side of it. The angle may be 0° center, 20° left, or 20° right. These angles are in relation to the tang, or locator tab on the pin, which is located along the true centerline of the pin.



Fig. 13- View of a pin stack, one with a hardened steel top pin and one with mushroom top pin.



Fig. 14- Side view of pin showing long and short chisel face

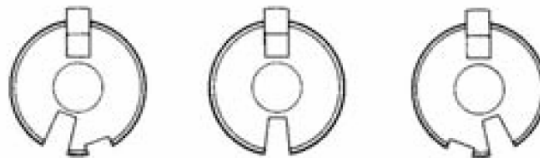


Fig. 15- Top view of left, center and right pins.

There are 6 types of Medeco biaxial pins, and they are K, B, Q, M, D, S. While there are only three angles available (20° left, 0° center, or 20° right), there are six pins, each of which is available in 6 heights. Each angle may be a fore or aft pin. Fore pins have the long chisel face to the right, and the chisel point offset 0.031" to the left of the centerline, whereas aft pins will have the long chisel face to the left, and the chisel point offset 0.031" to the right of the centerline. K, B, and Q are all fore pins, and M, D, and S pins are all aft pins. These pins have excellent wear resistance, because only the sides of the pins touch the key, and the small flat never contacts the key. The wear is spread out over a large area, instead of being focused on a small point. This, combined with the use of hardened brass, leads to excellent wear resistance.

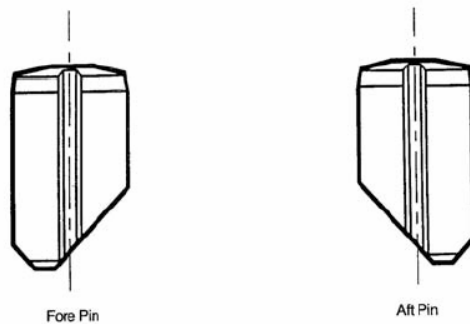


Fig. 16- Fore and aft pins.

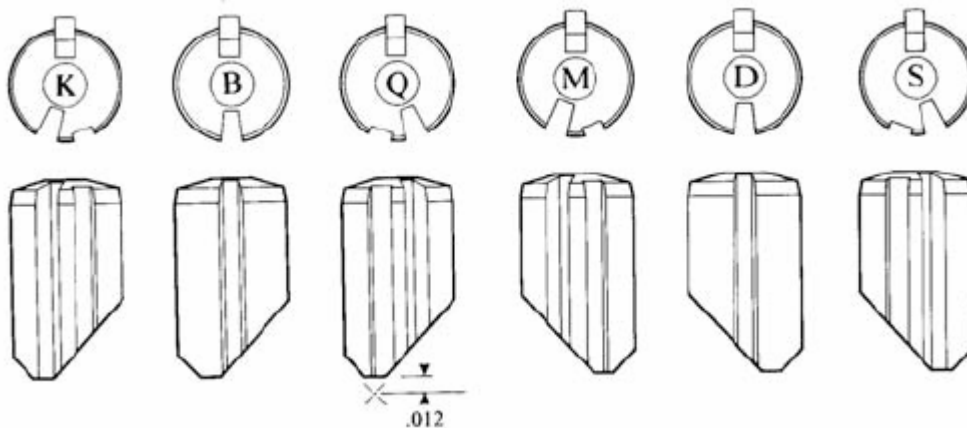


Fig. 17- The six different types of pins. Each of these pins is available in six lengths.

Each key pin also contains a small tang, or locator tab. This locator pin fits into a groove in the pin chambers in the plug, and in the bible of the lock. The purpose of the locator pin is to keep the pins from over rotating. If a pin were to complete a 180° turn, then it would lineup with the key, but the sidebar slot would be on the wrong side of the lock, and you would be unable to open the lock. The pin also contains a steel pin. Not only is this pin hard to drill thru, but they are all different weights. This throws off the weight of the pin, and makes one particular method of decoding impossible.



Fig. 18- Top view of a pin. The tang is the protrusion on the left hand side. The indent roughly opposite it is the sidebar slot. The center circle is a steel pin.

Also, each key pin contains a shallow sidebar slot, to discourage and further frustrate picking attempts. If the sidebar lines up with this slot, it can only retract part way, and therefore the lock cannot open.



Fig. 19- Side view of a pin. The true sidebar slot is on the left, the false one is on the right.

The driver pins (top pins) usually contain at least one mushroom pin. Many locks contain two or three of these mushroom security pins. These pins also frustrate picking attempts. Some locks, such as mine, may also contain a hardened steel pin, which is located in the pin stack closest to the face of the lock. This is to making drilling difficult. Not only is the steel hard to drill through, but a drill bit will spin it around without cutting into it.

The cylinder itself is made from brass, and is different from normal pin tumbler locks in four main ways. One is the slot milled down the side for the sidebar, and the other is the groove for the locator tab in the bible of the lock (where the pins go). The two other differences are the screw in pin covers, and the holes for the hardened crescents. All of these are shown in figures 3, 7, and 10.

## Operation

To open a Medeco Biaxial lock, the user must insert the correct key into the lock. The correct key will fit the keyway, and it will have the right cut depths and angle cuts. If the key fits the keyway, and has the right cut depths, then it will raise all of the pins to the correct height. This will raise all of the pins to the shearline. When the user turns the key, the sidebar is forced into the pins. If the correct key is used, the slots will line up and the plug will turn freely. If the wrong key is inserted, then the sidebar will be unable to fit into the slots, and the plug will be unable to turn, since the sidebar is blocking its rotation.



Fig. 20- Medeco Plug, with the correct key inserted.



## **Strengths and Weaknesses**

Although Medeco certainly offers more protection than standard pin tumbler locks, there are still some things that need to be improved on.

One of the first problems with Medeco locks is key control. Although restricted key blanks are hard if not impossible to obtain, a copy can be made of even the most restricted key using a clamshell kit. If someone has access to the key for even 30 seconds, they can make a copy of the key using a clamshell kit. The clay impression that is made can be used to then cast a working key. This is fairly easy to do, even using homemade supplies, such as a mint tin and clay. Although this is a weakness, most common as well as high security locks are susceptible to this technique.

The hole in the cam is also a problem, because Adams rite trip wires can be inserted through these holes, and used to manipulate the bolt. However, this problem is easily fixed by using a covered cam, and this is a very cheap fix.

Another problem is forced entry. Although the pins and sidebar are well protected, the rest of the face is not well protected. If the lock is a rim lock, then the two screws keeping the lock in place can easily be drilled out, as the body of the lock is made of brass. If the lock is a mortise lock (one that screws in) then the screw that fits into the side of the lock cylinder it can easily be drilled out. Once the screw or screws were drilled out, the lock could simply be removed from its housing, exposing the inner mechanism of the door lock. Then the door lock can be opened using a piece of metal such as a screwdriver. In order to prevent this, I think the entire front face of the lock should be made of hardened steel.



Fig. 21- Drilling points for screws on two standard cylinders.

Rights amplification is also a problem with Medeco locks. Medeco pins can only have one true sidebar slot in them. Therefore, each lock in a master keyed lot must all have the same sidebar configuration. This can lead to rights amplification, seeing as how if you are in possession of an operating key, you can easily tell the angle cuts. From this, you can with access to a Medeco key machine and proper blanks, create a master key through a somewhat lengthily process. This attack is possible, if someone was highly motivated. Also, if you know the angle cuts for a particular set of locks, then you can cut a 999 bump key that matches these angle cuts, and then it is possible to bump the lock. However, the angle cuts must be known in order for a Medeco lock to be bumped.

Lock one operating key- 1L2R3C4R5L

Lock two operating key- 2L3R6C2R4L

Lock three operating key- 3L4R6C2R4L

Lock four operating key- 3L4R3C4R2L

Master key for above locks- 2L3R4C2R3L

The master key must have angle cuts of LRCRL, and can not have any other angle cuts. If you were to make a bump key for the above locks, it would be cut 6L6R6C6R6L.

## Picking

Picking a Medeco is normally a fairly complicated task. First, you must pick the lock as if it were a normal pin tumbler lock, by lining the pins up to the shear line. Then, using a pick, you must rotate each pin so that it lines up with the sidebar. This is a fairly difficult task!

I noticed something about the Medeco locks though, and that is that the key cuts are always an  $86^\circ$  valley, and the cuts are always either center, or offset left or right  $20^\circ$ . So, if you can create three picks with a valley equaling  $86^\circ$ , and make one each of left right and center picks, setting the sidebar should be fairly simple!

The picks were very difficult to make, and had to be hand made. First, I made a template that had a valley equaling  $86^\circ$ , and bent it to fit my vise. This will allow me to file the valley correctly. Then, three file guides were made, one bent at  $90^\circ$  to make the  $0^\circ$  angled pick, one made at  $110^\circ$ , to make the  $+20^\circ$  pick, and finally one made at  $70^\circ$  to make the  $-20^\circ$  pick.



Fig. 22- Medeco pick making jig, with file attachments to the right.

Now all I had to do was file the picks! I added a riser to the bottom of the valley template, to bring the picks up to the right height to be filed.



Fig. 23- Medeco pick jig, with riser added.

Then, I filed a shallow starter cut into where the valley of the pick would go. The pick was clamped into the jig, and the appropriate file guide was added. Then, the picks were filed using the smallest file I had.



Fig. 24- Full Medeco pick jig setup.

Finally, the picks were filed down into a pick shape, and the laminated with popsicle sticks, to increase the size of the handle, thus making the picks easier to use.



Fig. 25- Completed Medeco picks.

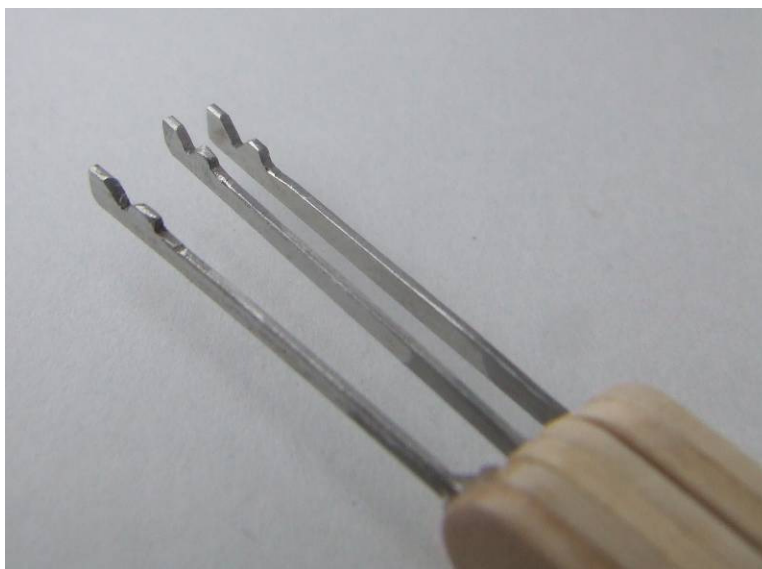


Fig. 26- Medeco pick tips.

## Using the picks

First the Medeco is picked like a normal pin tumbler lock, using a hook pick. Once the lock is picked like a normal pin tumbler lock, each angle pick is used to probe each pin. It is easy to tell when a pin sets, it will go from being very hard

to move to all of a sudden setting, and feeling like there is no pressure on it, even when heavy pressure is applied. By varying the pressure on the tension wrench, and trying to wiggle the pins a little, it is easy to tell which pins are set.

Although these picks will not magically open Medeco locks, I think they do make them significantly easier to pick. One downside to them is that you have to change picks four times when picking the lock. However, they make setting the sidebar much easier. I am currently up to picking 3 pins successfully, and I have only been trying for half an hour.



## **Conclusion**

The Medeco biaxial lock is fairly secure; however there is definitely some room for improvement. My two main concerns are the hole in the cam, and the unprotected rim and mortise screw(s). Both problems are easily fixed, simply by using covered cams and having the entire lock face made of hardened steel, although this could raise production costs. Key casting is not a big worry, because as long as the user keeps a hold of there key, it cannot be compromised. Furthermore, casting is something almost every mechanical lock is susceptible too, and making lock casting proof is very difficult.

The picks I made were very difficult to make. They came out great in the end, and they work wonderfully. If these picks were made using more precise measures, such as actually cutting the picks with a Medeco key machine, I think they would work even better. Personally, my picks could have been a little shorter. I think I'll shorten them down, after a little more playing around.

I think these picks have a lot of potential. I would like to have a set professionally made, on a Medeco key machine, as I think they'd be a lot more effective. They're great because the immediately rotate the pin to one of the correct angles, unlike other Medeco picks. If possible, I hope to make a video of me using the picks soon, after I've had a bit more practice with them. I'm also trying to design one pick that will do the job of all three, which would be even better, since you wouldn't have to constantly change picks.

## **References and Thanks**

Special thanks to Linty from Lockpicking101.com for the six Medeco pins shown in picture 17, and for the two crescents shown in picture 9.

The Complete Book of Locks and Locksmithing, 6<sup>th</sup> edition, by Bill Phillips.

Medeco Biaxial Technical Service Manual- Pictures 15, 16, 17.